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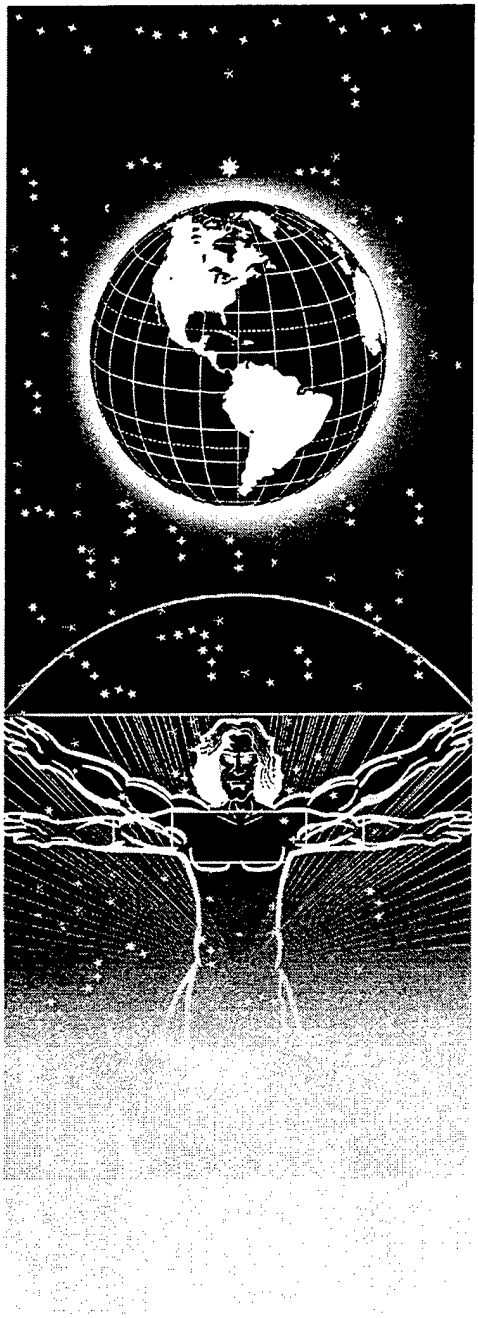

AIR FORCE MATERIEL COMMAND
AIR FORCE RESEARCH LABORATORY

USAF AIR VEHICLE OPERATOR TRAINING REQUIREMENTS STUDY

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February 1998

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The Public Affairs Office has reviewed this paper, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This paper has been reviewed and is approved for publication.

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This study was initiated to examine questions raised at Corona South '97 regarding the type of training pipeline that would need to be established within the Air Force for training pilots of current (i.e., Predator) and future (e.g., Global Hawk and Dark Star) unmanned aerial vehicles (UAVs) and unmanned combat aerial vehicles (UCAVs). Although Air Combat Command now uses rated Air Force pilots to fly the Predator, a secondary issue addressed by the study is the feasibility of establishing an enlisted air vehicle operator specialty within the Air Force. The study employed a combination of a survey and focus group discussions conducted with Predator AVOs assigned to the 11th and 15th Reconnaissance Squadrons between August and December of 1997. The study sampled the opinions of virtually 100% of the trained Air Force AVOs, and the reliability on the written survey was extremely high (Spearman-Brown estimate of reliability equals .88). The results of the study indicate that current Predator pilots believe that training requirements prior to Predator initial qualification training (IQT) are roughly equivalent to undergraduate pilot training (UPT) received by AF pilots of manned aircraft. Further, they believe that manned aircraft flying experience is essential to effective employment of the Predator. Although these pilots believe that a carefully screened portion of enlisted personnel could successfully complete such training, members of the focus group discussions unanimously expressed concern with giving enlisted personnel the decision-making responsibilities necessary for effective Predator employment. The study yielded very little useful information regarding the training requirements for future UAV and UCAV systems.

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TABLE OF CONTENTS

PREFACE

This report describes the results of a study conducted at the request of Air Combat Command, Director of Operations for Unmanned Aerial Vehicles, to determine the training requirements for unmanned aerial vehicle pilots. The work was conducted by the Mission Critical Skills and Warfighter Training Research Divisions of the Air Force Research Laboratory's Human Effectiveness Directorate. It covers the period from August through December, 1997.

We would like to thank the Predator air vehicle operators assigned to the 11th and 15th Reconnaissance Squadrons for their participation in this study. This work could not have been accomplished without their dedicated support. We would also like to thank Mr. Stan Baker for his invaluable assistance in coordinating this effort, and Ms Kathy Underwood for her help in constructing the survey. Finally, we would like to thank Dr. Elizabeth Martin, Dr. William Alley, Dr. Pat Kyllonen, Col. Gary Zank, and Mr. Paul Parker for their extremely helpful comments and suggestions.

USAF Air Vehicle Operator (AVO) Training Requirements Study

Summary

This report describes the results of a study conducted at the request of Air Combat Command, Director of Operations for Unmanned Aerial Vehicles (HQ ACC/DOU). The study was initiated to examine questions raised at Corona South '97 regarding the type of training pipeline that would need to be established within the Air Force for training pilots of current (i.e., Predator) and future (e.g., Global Hawk and Dark Star) unmanned aerial vehicles (UAVs) and unmanned combat aerial vehicles (UCAVs). Although ACC now uses rated AF pilots to fly the Predator, a secondary issue addressed by the study is the feasibility of establishing an enlisted AVO specialty.

The study employed a combination of a survey and focus group discussions conducted with Predator AVOs assigned to the 11th and 15th Reconnaissance Squadrons at Indian Springs Air Force Auxiliary Field Nevada between August and December of 1997. The survey and focus group discussions sampled the opinions of virtually 100% of the trained Air Force AVOs, and the reliability on the written survey was extremely high (Spearman-Brown estimate of reliability equals .88). The results of the study indicate that current Predator pilots believe that training requirements prior to Predator initial qualification training (IQT) are roughly equivalent to undergraduate pilot training (UPT) received by AF pilots of manned aircraft. Further, they believe that manned aircraft flying experience is essential to effective employment of the Predator. Although these pilots believe that a carefully screened portion of enlisted personnel could successfully complete such training, members of the focus group discussions unanimously expressed concern with giving enlisted personnel the decision-making responsibilities necessary for effective Predator employment. The study yielded very little useful information regarding the training requirements for future systems, whether reconnaissance aircraft that operate at higher altitudes than the Predator (Global Hawk and Dark Star), or whether combat aircraft that perform some mission such as suppression of enemy air defenses.

Introduction

This study was undertaken to establish the level of training necessary to prepare AVOs for IQT on specific UAV systems. While the study focused primarily on Predator IQT, training requirements for future UAVs and UCAVs were also addressed. The focus on Predator training is due the Predator's status as the only operational UAV currently being employed by the Air Force which is using it for reconnaissance in Bosnian peacekeeping operations. Further, because there is not a separate pipeline for training prior to Predator training, the Air Force currently assigns pilots qualified to fly manned aircraft to the two existing Predator squadrons since they already possess the skills necessary to successfully complete Predator IQT and employ it in Bosnia. Due to the current shortage of rated Air Force pilots and the cost to train them, Air Force leaders agreed during the Corona South 97 Conference to address whether a requirement for that level of training was warranted for pilots of UAVs. Thus, the first two research questions this study addressed were:

1. What piloting skills should be taught to prepare an AVO candidate for Predator training?
2. How would training requirements change with future UAV/UCAV systems?

Under direction from the House Permanent Select Committee on Intelligence, ACC/DOU requested that the study also address the feasibility of an enlisted AVO specialty in the Air Force. The committee inserted language into the FY98 Defense authorization bill which charges the Air Force with conducting a study of creating an enlisted pilot specialty code for the Predator UAV. The committee's reasons for directing the study are based on the fact that the Army, Navy and Marines use enlisted personnel to pilot their UAVs. The study thus addressed a third research question:

3. Could enlisted personnel serve as AVOs?

Although conducted at the request of HQ ACC/DOU, this study was funded by the Human Effectiveness Directorate of the Air Force Research Laboratory (AFRL) and performed by staff scientists from two of its research divisions between August and December 1997. The results were briefed to ACC/DO and his staff on 30 December. The briefing is included here as Appendix A. The remainder of this paper describes the methodology employed, describes the results, and summarizes the study's conclusions.

Method

This study employed a combination of a survey and follow-up focus group discussions to examine the three research questions outlined in the previous section. The survey approach was used because of the limited time available to conduct the study. The survey approach had the virtue of sampling almost the entire population of trained Air Force Predator pilots, the only expertise that currently exists within the Air Force on the issues in question.

Participants. At the time the survey was conducted, there were 12 AVOs assigned to the 11th and 15th Reconnaissance Squadrons who had completed Predator IQT. Of these, four were deployed to Bosnia. The eight AVOs remaining at Indian Springs responded to the written survey. The mean number of manned aircraft flying hours for this group was 2,599 with a range of 355 to 3,950 (standard deviation was 1214). The focus group discussions took place approximately three and one half months after the survey was initially delivered to the respondents. Two of the AVOs who participated in the survey also took part in these discussions, along with an additional 13 AVOs who had completed Predator IQT but did not take part in the survey. The other six survey respondents were either deployed when the focus group discussions took place or had been reassigned. Two additional AVOs who were in Predator IQT at the time also took part in the focus group discussions.

Survey construction and administration. Appendix B contains the survey that was administered to Predator AVOs between August and October, 1997. The survey's goal was to identify which piloting skills AVOs had acquired prior to Predator IQT that were actually needed in learning to fly the Predator. The survey was constructed by listing all training tasks from undergraduate pilot training (UPT) courses prior to fighter (T-38) or heavy aircraft (T-1) training. In other words, the survey contained the entire set of training tasks that every Air Force pilot receives, and included all 136 flying training tasks from the T-3 Enhanced Flight Screening Program, the T-37 Instrument Training Maneuvers course, and the T-37 Navigation Training Maneuvers course.[1] In addition, the 28 tasks from the FAA Instrument Rating Practical Test Standards (FAA-S-8081-4B) were included in the survey because they constitute the skills necessary for private pilots to obtain an instrument rating. Thus, they were included to determine whether training equivalent to the FAA instrument rating would suffice for Predator AVO candidates. T-38 and T-1 training tasks were not included because the training histories of survey respondents varied with respect to these courses and because it was originally assumed by the researchers that jet training would not be relevant to Predator flying. Finally, the survey listed all 61 tasks from the Predator IQT course to obtain benchmark ratings on tasks that were clearly relevant to Predator flying.

Participants were asked to rate each task using a three-point scale according to its relevance in preparing a candidate for eventual assignment as a Predator AVO. A rating of one was defined as "not applicable," a rating of two was defined as "nice to have but not necessary," and a rating of three was defined as "absolutely necessary. In order to address the question of how training requirements might change with future systems, particularly UCAVs, participants were then asked to go back and identify those tasks that they would rate differently if the UAV had a combat mission. In addition to the training task lists, the survey contained a number of other open-ended training-related questions to which participants could respond in any manner they chose. Included were questions on additional training requirements for future UAVs and UCAVs and questions regarding the feasibility of establishing an enlisted AVO specialty within the Air Force.

[1] Tasks from ground school portions of these courses were not included since they are prerequisites for the flying training tasks and were therefore assumed by the flying training portions of the courses.

Prior to administering the survey, members of the ACC/DOU staff reviewed its content to determine whether it adequately addressed the questions they were interested in examining. Only minor changes in wording were made to two items as a result of this review. The survey was then sent to the 11th RS and distributed to the eight AVOs in residence at the time. Each respondent completed the survey individually at his or her own leisure. The completed surveys were then collected and returned to AFRL where the results were analyzed.

Focus group discussions. The purpose of the focus group discussions was to obtain feedback from the AVOs (primarily those who had not had the opportunity to respond to the survey) on whether the results of the survey made sense to them. Two focus group sessions were conducted in early December 1997 at Indian Springs where the second author briefed these results and led the discussions while the first author took notes on the discussions. Nine AVOs participated in the first session while six AVOs participated in the second session. Both sessions lasted approximately two and one half hours. Appendix C contains the briefing that was presented to the AVOs and describes the survey results.

Results

In this section, the results of the study are described in terms of the three research questions outlined earlier. For each question, the survey results are considered first, followed by the outcome of the focus group discussions.

What piloting skills should be taught to prepare an AVO candidate for Predator training? Table 1 contains the number and percentage of tasks from each training course included in the survey that were rated as "not applicable," "nice to have but not necessary," and "absolutely necessary." While 100% of the tasks from the Predator ground control station and flying courses were rated as "absolutely necessary," 70% of the 165 tasks from the T-3, T-37, and FAA courses were rated as such. Another 25% were rated "nice to have but not necessary" and in general, included tasks involving instrument maneuvers using navigation systems that are not used by the Predator (TACAN, VOR, and ILS). The remaining 5% of the tasks were rated "not applicable" and included those from the T-3 training course involving aerobatic maneuvers that are not performed by the Predator (Cuban 8, Chandelle, Immelman, Cloverleaf, Aileron Roll, Loop, Lazy 8, and Barrel Roll). Appendix B contains the mean ratings for each survey item in which a rating was given.

Although the population of AVOs (and thus the sample for this survey) was small, the level of agreement among AVOs on these survey items as measured by the average inter-rater correlation ($r=.47$) is fairly high and has a Spearman-Brown estimate of reliability of .88.

Table 1. Number of tasks in flying training courses rated as "not applicable," "nice to have but not necessary," and "absolutely necessary". Percentages of tasks from individual courses are given in parentheses.

Training Task List	Not Applicable (1.00 - 1.50)	Nice-to-have < Necessary (1.63 - 2.38)	Absolutely Necessary (2.43 - 3.00)
T-3 Flying	8 (15.1%)	10 (18.9%)	35 (66.0%)
T-37 Instrument Training Maneuvers	0 (0%)	12 (28.6%)	30 (71.4%)
T-37 Navigation Training Maneuvers	0 (0%)	11 (26.8%)	30 (73.2%)
FAA Instrument Rating	0 (0%)	10 (35.7%)	18 (64.3%)
Predator Ground Control Station	0 (0%)	0 (0%)	23 (100%)
Predator Flying	0 (0%)	0 (0%)	38 (100%)
All Tasks	8 (3.6%)	43 (19.1%)	174 (77.3%)

The result that a very large subset (70%) of the T-3, T-37, and FAA training tasks were judged as absolutely necessary to successfully prepare a pilot for Predator training was basically confirmed in the focus group discussions. However, AVOs in these discussions agreed (somewhat surprisingly) that even tasks rated in the survey as "nice to have" and "not applicable" might be necessary for Predator pilots. There were several reasons for this conclusion. First, the focus groups were initiated by asking the AVOs whether an assumption that was both implicit and explicit in the survey (see Appendix B, survey instructions) was valid: that manned aircraft flying experience was necessary for learning to fly the Predator. AVOs unanimously agreed that such experience was in fact necessary because it "gave you the ability to project yourself into the aircraft" which was in turn required "to maintain situational awareness." Once it had been established that some manned aircraft training was required, AVOs agreed that tasks involving navigation systems not used by the Predator (i.e., tasks rated "nice to have but not necessary" in the survey) might be indirectly relevant because of the manned aircraft training requirement. In addition, AVOs stated generally that all the training tasks listed on the survey, including those rated "not applicable" could teach something about airmanship that is required for flying the Predator. One AVO stated, for example, that aerobatics taught energy management. Others noted that some of the skills they had acquired in T-1 or T-38

training were relevant. Although they acknowledged that some of these skills could be taught in other ways (i.e., without the use of aerobatic maneuvers or jet training), they consistently expressed concern with the idea that Predator pilots somehow require "less training" or "a shortened training course" relative to pilots of manned aircraft. In fact, although their assignment to a Predator squadron has posed significant career problems for these pilots, none expressed the opinion that they were overqualified for their assignment when asked. Finally, there was general agreement to the statement made by one AVO that regardless of who the Air Force uses to fly UAVs in the future or what the future training pipeline looks like, the Air Force needs to build up a "pool of expertise" now to determine what those training requirements should be.

How would training requirements change with future UAV/UCAV systems? The survey failed to yield much useful information regarding training requirements for future UAVs and UCAVs. Only three of the eight survey respondents rated the tasks for this question, while AVOs in the focus groups stated that it was difficult to determine the training requirements for systems with unspecified missions or capabilities. They did, however state one concern that was generally agreed upon by participants in the focus groups. Noting that missions involving the expenditure of weapons would confer an even greater level of responsibility on the AVO than noncombat missions, AVOs unanimously expressed concern with the potential use of enlisted personnel in this capacity stating that the Air Force has traditionally assigned officers to positions with that level of responsibility (see also discussion in the following section).

The remainder of the comments made during the focus group discussion on this question did not necessarily receive the unanimous support of all participants but are included here as insights provided by individual experts. First, some AVOs stated that automation of some functions would not necessarily reduce the training requirements because they believed there were some critical functions that could not be automated. One AVO cited the decision-making skills needed to deal with adverse weather as an example of such a function. Second, the AVOs stated that the aircraft used for flying training should depend on the mission. For example, while some of the AVOs advocated a single-propeller aircraft for training Predator pilots because of similarities in airspeed and response of the aircraft in adverse weather conditions, they noted that jet aircraft might be more appropriate for training UCAV pilots. Finally, the specific changes in training requirements for UCAVs mentioned either by survey respondents or focus group participants were the need to train airspace coordination and operating in non-restricted airspace, the need to include enemy threat courses in mission qualification training, and the need to include aerobatic maneuvers in flying training.

Could enlisted personnel be trained to pilot the Predator? Six of the eight survey participants responded to this question and all believed that enlisted personnel could be trained to fly the Predator. However, in the focus group discussions it became clear that AVOs believed that the feasibility of an enlisted AVO specialty depended on much more than simply their ability to fly the aircraft. As one AVO put it, "you have to teach them to fly, you have to teach them to fly this aircraft, and you have to teach them to employ the

aircraft." AVOs in the focus group were unanimous in their concern over giving enlisted personnel the level of responsibility necessary to effectively employ the Predator. They noted the need for quickly and accurately making difficult decisions, effectively communicating those decisions both to subordinates as well as to higher levels, and being responsible for making sure they are implemented. Although they said some enlisted personnel could conceivably acquire these skills through training, they would have to be carefully selected, and they noted that training would take longer with enlisted personnel than with officers (particularly rated pilots) who already possess these skills. As mentioned earlier, the AVOs also stated that concerns regarding the level of responsibility would be magnified with the use of UCAVs and would expand the training requirements even further. Finally, the AVOs agreed that the feasibility of an enlisted AVO specialty would ultimately depend on both a significant change in Air Force policy and the Air Force's willingness to provide the necessary screening and training capabilities.

Conclusions

Perhaps the most significant finding of this study was the unanimous agreement among Air Force experts that manned aircraft flying experience is necessary to effectively employ the Predator. If correct, it has significant implications for the cost of training UAV pilots which in turn could influence which options are considered regarding what kind of personnel should be trained as AVOs. The continued use of rated pilots is certainly one option that ensures AVOs have the necessary experience. It might also be considered a lower cost alternative when compared with the costs of selecting and training enlisted personnel, particularly if those pilots can also be used to fly other aircraft. As noted in the previous section, AVOs in the focus group discussions clearly agreed that the training requirements for Predator were not significantly different from those for manned aircraft (the survey and focus group discussions suggest that it is roughly equivalent to UPT) and the use of enlisted personnel as AVOs would expand those requirements significantly. The use of UAVs in combat missions would expand the requirements still further according to these experts.

The expanded training requirement is thus one factor that could make the use of enlisted personnel a more costly alternative. Another factor that could influence the cost to the Air Force is the number of enlisted personnel who could successfully complete the training, and the competition for those personnel from other career fields. AFRL routinely conducts studies in which random samples of airmen in basic training are given the AFOQT (e.g., Glomb and Earles, 1997). Figure 1 shows the distribution for one such sample on the AFOQT pilot composite, the best single predictor of success in UPT. Figure 2 contains the same distribution for officer candidates (USAFA and ROTC). Both figures show the cutoff scores for UPT and indicate that while 96% of officer candidates exceed the UPT cutoff, only 24% of the airmen in this sample did so.[2] Thus, an enlisted AVO career field would have to draw personnel from roughly the top of quarter of the

[2] It should be noted that the careers of airmen basics taking this test were not influenced by their test performance. Thus, airmen were not motivated in the same way as officer candidates to perform well on the test.

distribution from which other enlisted specialties requiring high-ability individuals (e.g., electronics specialties) also draw. Depending on manpower requirements for all such specialties, the Air Force could experience shortages not much different from the pilot shortage that currently exists. In fact, if one assumes that enlisted AVOs would have to meet the same selection criteria as AVOs as pilots selected for UPT, then the sample of qualified enlisted personnel would be much smaller: the mean score on the pilot composite for officers actually selected for UPT is 141, and only .55% of the airman basics in this sample met or exceeded that standard. Nevertheless, manpower modeling studies would need to be conducted to predict when and if such shortages would actually occur.

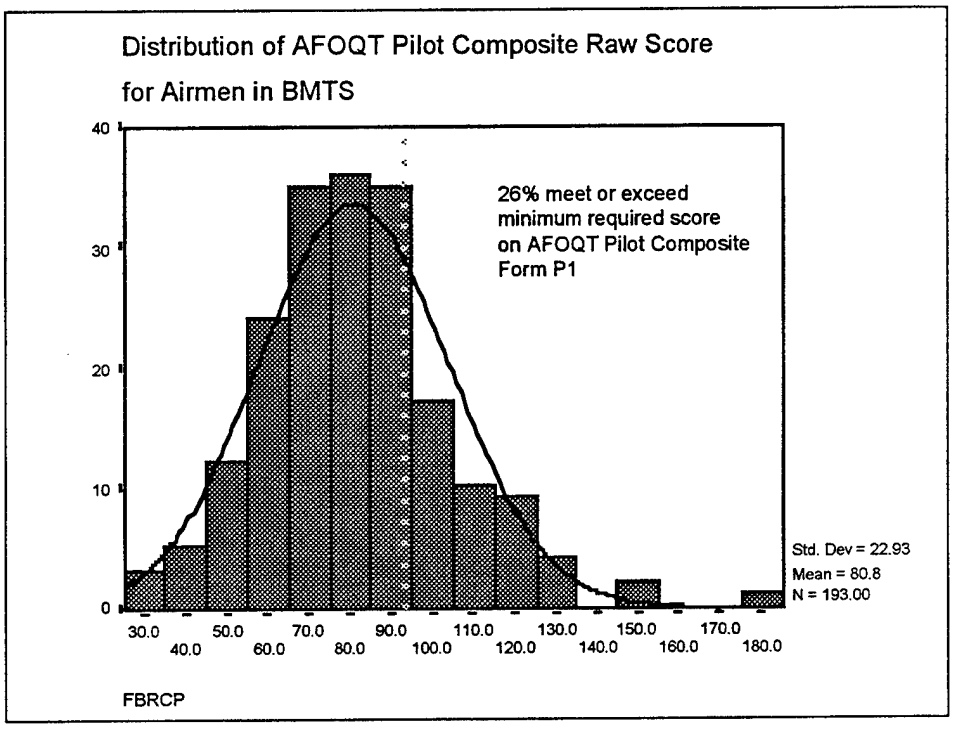


Figure 1. Distribution of a random sample of 193 airman basics on the pilot composite of the AFOQT.

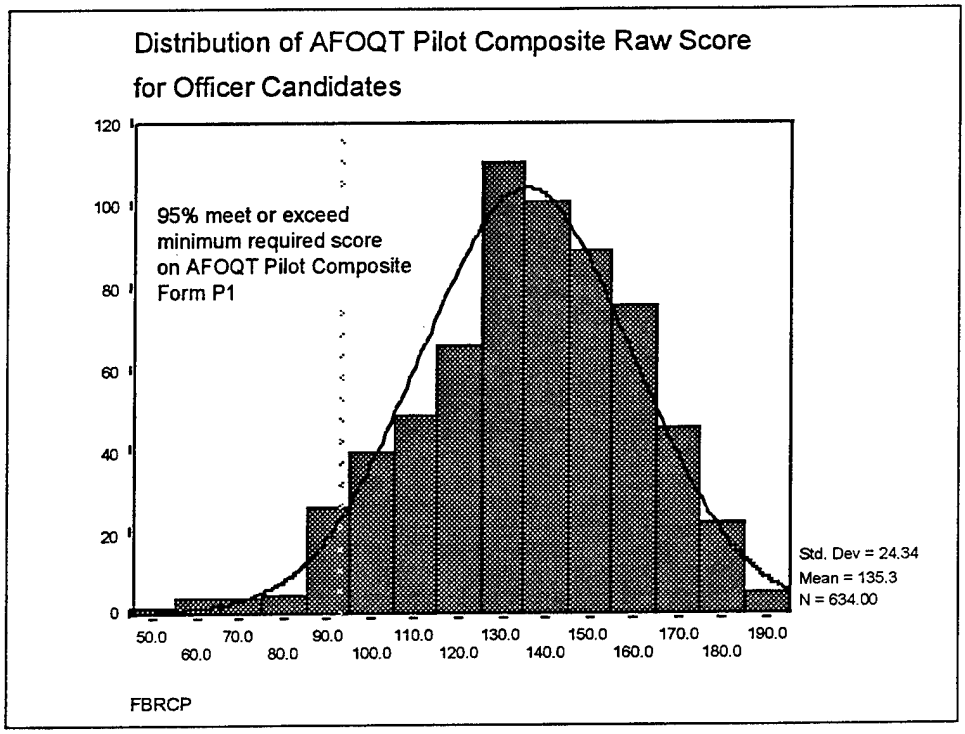


Figure 2. Distribution of a random sample of 634 USAFA and ROTC cadets on the pilot composite of the AFOQT.

The finding that manned aircraft flying experience is necessary for Predator AVOs is also likely to be the most controversial finding of this study since many Army, Navy and Marine AVOs have no such experience. The fact that Predator AVOs unanimously believed it was necessary is perhaps not surprising since they all acquired their piloting skills through manned aircraft training. Certainly that training enabled them to learn to fly the Predator faster than if they had had no prior flying experience, and using pilots as AVOs surely reduces Predator-specific training requirements.[3] However, more systematic research methods would be needed to definitively establish the tradeoffs between flying training that involves manned aircraft versus simulation or some other form of flying training. Would manned aircraft pilots exhibit greater situational awareness in Predator flying than those with equal flying experience trained through other means? Would the latter group simply take longer to acquire the skills necessary to reach that level of performance or would they never reach it? Would the time required to train pilots to a given performance standard be so different with the various training methods that one method, though more expensive, might be demonstrably more cost effective? Or would

[3] This finding may also be consistent with an option to use officers as AVOs who are not rated AF pilots but who have obtained an FAA instrument rating since they have the manned aircraft experience and officer training that may alleviate some of the costs associated with training AVOs. However, the option is not discussed here since it is unclear from the results of this study whether there are differences between the FAA rating and UPT that might preclude this as an option.

the differences in training outcomes be so minimal that the lower-cost training alternative could be justified?

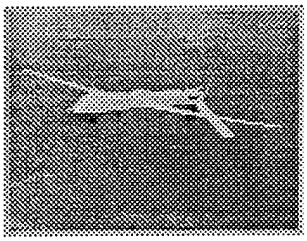
While the survey methodology employed here is certainly not adequate by itself for answering the questions just raised, the results certainly reveal support from virtually all of the trained experts for the Air Force's decision to use rated pilots as AVOs. As such the study provides an important piece of information for Air Force decision makers on the question of who should serve as AVOs and sets some boundaries on the issue of AVO training requirements.

Reference

Glomb, T.M. and Earles, J.A. (1997). Air Force Officer Qualifying Test (AFOQT): Forms Q Development, Preliminary Equating and Operational Equating. Armstrong Laboratory Technical Paper (AL/HR-TP-1996-0036), Human Resources Directorate, Manpower and Personnel Research Division, Brooks AFB TX.

Appendix A
AVO Training Requirements Study
Briefing presented to ACC/DO 30 Dec 1997

AVO Training Requirements Survey



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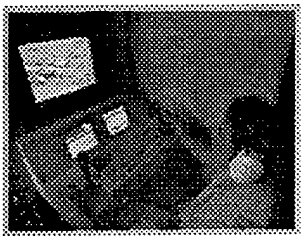


Overview

- Purpose
- Research Questions
- Method
- Results
- Conclusions

Purpose

- Present results of Predator AVO training requirements survey to ACC/DO

Research Questions

- Could enlisted personnel serve as AVOs?
- What piloting skills should be taught to prepare an AVO candidate for Predator operation?
- How would training requirements change with future UAV/UCAV systems?

Method

- Eight 11/15 RS AVOs surveyed to identify skill requirements and other issues pertaining to training (Aug/Oct)
- Survey content was based on the training experiences common to all USAF pilots prior to the T-38 vs. T-1 decision
- Used syllabi from existing programs as source of training tasks
  - T-3 Enhanced Flight Screening Program
  - T-37 Instrument Training Maneuvers
  - T-37 Navigation Training Maneuvers
  - FAA-approved Instrument Rating
  - Predator Initial Qualification Training
- Used 3-point scale
- Asked other training questions in free response format
- Follow-up focus groups with 15 AVOs as sanity check (Dec)

Results

Could enlisted personnel be trained to pilot the Predator?

- 6 of 8 AVOs responded to the survey question; all believed enlisted personnel could be trained to fly Predator
- Response confirmed in focus group discussions
- All voiced concerns with level of responsibility
  - operations near/over sensitive borders
  - expenditure of weapons in future UCAVs

Results

What piloting skills should be taught to prepare an AVO candidate for Predator operation?

Survey Summary: Number (%) of Tasks by Category

Training Task List	Not Applicable (1.00 - 1.50)		Nice-to-have < Necessary (1.63 - 2.38)		Absolutely Necessary (2.43 - 3.00)	
T-3 Flying	8	(15.1%)	10	(18.9%)	35	(66.0%)
T-37 Instrument Training Maneuvers	0	(0%)	12	(28.6%)	30	(71.4%)
T-37 Navigation Training Maneuvers	0	(0%)	11	(26.8%)	30	(73.2%)
FAA Instrument Rating	0	(0%)	10	(35.7%)	18	(64.3%)
Predator Ground Control Station	0	(0%)	0	(0%)	23	(100%)
Predator Flying	0	(0%)	0	(0%)	38	(100%)
All Tasks	8	(3.6%)	43	(19.1%)	174	(77.3%)

Results

What piloting skills should be taught to prepare an AVO candidate for Predator training?

- Survey Results
  - 70% of T3, T37, and FAA training tasks rated as "absolutely necessary"
  - Tasks rated "unnecessary" were T3 tasks involving aerobatic maneuvers not performed by Predator
  - Tasks rated "nice to have but not necessary" involved instrument maneuvers using TACAN/VOR/ILS navigation systems not used by Predator

Results

What piloting skills should be taught to prepare an AVO candidate for Predator training?

- Focus Group Results
  - AVO consensus is that manned aircraft flying experience is required
    - Telepresence
    - Situational awareness
  - Tasks rated "nice to have but not necessary" in survey are relevant to piloting Predator
    - Navigational systems not used by Predator are used by manned aircraft that may serve as training platform

Results

What piloting skills should be taught to prepare an AVO candidate for Predator training?

- Focus Group Results (cont'd)
  - All tasks teach airmanship skills that are relevant to piloting Predator
    - E.g., Aerobatic maneuvers teach energy management
  - Recommended pre-Predator training requirements comparable to UPT
  - AVOs believed there is a need to develop "pool of expertise" to determine specific training requirements

Results

How would training requirements change with future UAV/UCAV systems?

- Survey results inconclusive; 3 of 8 responded
- Focus group results
  - Specific concerns
    - Level of responsibility
    - Increased automation does not reduce training requirements
    - Operating in non-restricted airspace; would need to teach airspace coordination
    - Choice of training platform should depend on the mission

Conclusions

- Carefully screened portion of enlisted personnel possess capability to successfully complete basic flight and AVO upgrade training
- Training requirements prior to Predator
  - AVO consensus is that UPT-equivalent training required
  - Other techniques can provide more detailed information regarding specific training requirements
- Training requirements for future UAVs/UCAVs unknown

Appendix B
AVO Survey with Means and Standard Deviations of Rated Items

Air Vehicle Operator Training Requirements Survey[i]

The purpose of this survey is to identify all required training tasks to initially qualify a person with no prior training in aviation to become an air vehicle operator for the Predator. We need your help to accomplish this.

A separate pilot training pipeline is likely to be established for Predator air vehicle operators (AVOs). Assuming that AVOs will continue to train first on conventional manned aircraft, what skills need to be mastered in a conventional aircraft that would help prepare a pilot for eventual assignment as a Predator AVO? *Keep in mind, that it is possible that some piloting skills might not ever be exercised in a Predator, but still be important because they would have positive transfer to the Predator.*

Also, although the Predator does not currently have the capability to accomplish instrument approaches other than using a PAR, which is not available at Indian Springs AFAF, this capability will be added in the future. *Please keep this upgrade in mind as you respond to this survey.*

The following task lists were obtained from existing Air Force trainers. If there is a task that does not appear on this survey, but you feel it should be included, please add it to the comments section along with any other comments you wish to make.

The following tasks appear on the Enhanced Flight Screening Program syllabus conducted with the T-3. Please rate each T-3 flying task on the following scale:

1-Not applicable
2-Nice to have, but not necessary
3-Absolutely necessary

T-3 Flying Tasks

Mean	**S.E.**[4]	
3.00	.00	Ground Operations
3.00	.00	Takeoff
3.00	.00	Departure
3.00	.00	Climb

[4] Reported here are the means of the responses to the 225 task items and their standard errors (the standard deviation divided by the square root of the sample size, N). Items 1 to 164 had 8 respondents and items 165 to 225 (the section pertaining directly to Predator) had 7 respondents. Items that are clearly "absolutely necessary" are printed in green; and items that are clearly "not applicable" are printed in red.

Mean	S.E.	
3.00	.00	Level Off
3.00	.00	Straight And Level
3.00	.00	Turns
2.50	.27	Glides Normal
2.13	.30	Glides No Flap
2.50	**.27**	**Slow Flight Normal**
2.13	.35	Slow Flight No Flap
2.25	.31	Steep Turns
2.50	**.33**	**Power On Stalls**
2.50	**.33**	**Traffic Pattern Stalls - Normal**
2.25	.37	Traffic Pattern Stalls - No Flap
2.00	.33	Spin Prevention
1.63	.18	Spin
1.63	.32	Inverted Recovery
2.50	.33	Nose High Recovery
2.50	.33	Nose Low Recovery
1.63	.26	Split S
1.50	.27	Aileron Roll
1.50	.27	Loop
1.50	.27	Lazy 8
1.25	.16	Cloverleaf
1.25	.16	Immelman
1.25	.16	Chandelle
1.25	.16	Cuban 8
1.50	.27	Barrel Roll
3.00	.00	Inflight Planning
2.13	.30	VOR Operation/Orientation
3.00	.00	Recovery/Traffic Entry
2.75	.25	Normal Straight In

Mean	S.E.	
2.75	.25	Normal Pattern Left
2.75	.25	Normal Pattern Right
2.75	.25	Normal Landing
2.50	**.27**	**No Flap Pattern Left**
2.50	**.37**	**No Flap Pattern Right**
2.63	.26	No Flap Landing
2.87	.13	Low Altitude Simulated Forced Landing
3.00	.00	High Altitude Simulated Forced Landing
3.00	.00	Go Around
2.63	.26	Closed Pattern
2.25	.25	Pattern Breakout
2.75	.16	Clearing
3.00	.00	Inflight Checks
3.00	.00	Radio Procedures
3.00	.00	Trim
2.75	.25	Throttle Technique
3.00	.00	Situational Awareness
3.00	.00	Three Dimensional Airspace Awareness and Management
3.00	.00	Emergency Procedures
3.00	.00	General Knowledge

Comments:

The following task list originated in the instrument training phase of the T-37 syllabus. Assuming that the T-3 has been certified as an instrument trainer, rate the importance of the following instrument training tasks as preparation for a Predator AVO assignment. Please rate each task on the following scale:

1-Not applicable
2-Nice to have, but not necessary
3-Absolutely necessary

Instrument Training Maneuvers

Mean	S.E.	
3.00	.00	Ground Operations
3.00	.00	Takeoff/Transition To Instruments
3.00	.00	Departure
3.00	.00	Level-Offs
3.00	.00	Airspeed Control
3.00	.00	Altitude Control
3.00	.00	Heading Control
2.75	.25	Use Of Trim
3.00	.00	Turns
2.25	.25	Steep Turns
2.75	.25	Change Of Airspeed
2.75	.25	Airspeed Climbs/Descents
2.75	.25	Rate Climbs/Descents
2.38	.32	Vertical S
2.63	.26	Unusual Attitudes
1.75	.25	Confidence Maneuvers (Wingover, Aileron Roll)
2.50	**.27**	**Course Intercepts**
2.50	**.27**	**Maintaining Course**
2.50	**.27**	**Arc Interpretation**
2.25	.25	Maintaining Arc
2.00	.33	Course Interception/RMI Only
Mean	**S.E.**	

2.00	.33	Maintaining Course/RMI Only
2.25	.25	Fix-To-Fix
2.50	**.27**	**Holding**
1.75	.31	High Altitude VOR Approach
2.88	.13	Enroute Descent
2.25	.25	Low Altitude VOR Approach
3.00	.00	PAR Approach
2.38	.26	ILS Approach
2.13	.30	Localizer Approach
3.00	.00	ASR Approach
2.38	**.32**	**No-Gyro Approach**
2.88	.13	Transition To Landing
2.63	.26	Overhead Pattern
3.00	.00	Landing
3.00	.00	Missed Approach
3.00	.00	Cross-Check
3.00	.00	Inflight Checks
3.00	.00	Radio Procedures
3.00	.00	Situation Awareness
3.00	.00	Emergency Procedures
3.00	.00	General Knowledge

Comments:

The following task list originated in the navigation training phase of the T-37 syllabus. Assuming that the T-3 has been certified as a navigation trainer, rate the importance of the following training tasks as preparation for a Predator AVO assignment. Please rate each task on the following scale:

1-Not applicable
2-Nice to have, but not necessary
3-Absolutely necessary

Navigation Tasks

Mean	S.E.	
3.00	.00	Mission Planning
3.00	.00	Flight Log/DD 175 Preparation
3.00	.00	Ground Operations
3.00	.00	Takeoff/Transition To Instruments
3.00	.00	Departure
3.00	.00	Heading Control
3.00	.00	Altitude Control
3.00	.00	Airspeed Control
2.75	.25	Use Of Trim
2.75	.25	Map Reading
2.75	.25	Inflight Computations
2.25	.31	VFR Course Maintenance
2.25	.25	VOR Course Intercepts
2.25	.25	VOR Course Maintenance
2.13	.23	Fix-To-Fix Navigation
3.00	.00	GPS En Route Navigation
3.00	.00	GPS Approach
2.63	.18	Holding
3.00	.00	Enroute Descent
2.00	.27	High Altitude VOR Approach
Mean	**S.E.**	
2.25	.25	Low Altitude VOR Approach

2.25 .25 VOR Final Approach

3.00 .00 PAR Approach

2.25 .25 ILS Approach

2.25 .25 Localizer Approach

2.88 .13 ASR Approach

2.38 .26 Circling Approach

3.00 .00 Missed Approach

3.00 .00 VFR Arrival

3.00 .00 VFR Pattern

3.00 .00 Transition To Landing

3.00 .00 Landing

2.38 .26 Lost Procedures

3.00 .00 Inflight Planning

2.63 .26 Use of PMSV and ATIS

2.88 .13 Clearing

3.00 .00 Inflight Checks

3.00 .00 Radio Procedures

3.00 .00 Situational Awareness

3.00 .00 Emergency Procedures

3.00 .00 General Knowledge

Comments:

The following tasks appeared in the Instrument Rating Practical Test Standards (FAA-S-8081-4B). Please rate the importance of the following training tasks as preparation for a Predator AVO assignment using the scale below:

1-Not applicable
2-Nice to have, but not necessary
3-Absolutely necessary

Mean	S.E.	
		PREFLIGHT PREPARATION
3.00	.00	Obtaining Weather Information
2.75	.16	Cross Country Flight Planning
		PREFLIGHT PROCEDURES
2.50	.27	Aircraft Systems Related to IFR Operations
2.88	.13	Aircraft flight Instruments and Navigation Equipment
2.63	.18	Instrument Cockpit Check
		AIR TRAFFIC CONTROL CLEARANCES AND PROCEDURES
2.75	.25	Air traffic Control Clearances
2.75	.25	Compliance with Departure, Enroute and Arrival Procedures and Clearances
2.38	.32	Holding Procedures
		FLIGHT BY REFERENCE TO INSTRUMENTS
3.00	.00	Straight and Level Flight
3.00	.00	Change in Airspeed
3.00	.00	Constant Airspeed Climbs and Descents
3.00	.00	Rate Climbs and Descents
2.25	.31	Timed Turns to Magnetic Headings
2.00	.33	Steep Turns
2.75	.25	Recovery from Unusual Attitudes
		NAVIGATION AIDS
2.13	.30	Intercepting and Tracking VOR/VORTAC Radials and DME arcs
1.75	.31	Intercepting and Tracking NDB Bearings
		INSTRUMENT APPROACH PROCEDURES
2.13	.30	VOR/VORTAC Instrument Approach Procedures
1.88	.30	NDB Instrument Approach Procedure
2.13	.30	ILS Instrument Approach Procedure
3.00	.00	Missed Approach Procedures
2.50	.19	Circling Approach Procedures
3.00	.00	Landing from a Straight in or Circling Approach

Mean	S.E.	
		EMERGENCY OPERATIONS (MULTIENGINE)
2.75	.25	Engine Failure During Straight & Level Flight & Turns

2.63 .26 Instrument Approach - All Engines Operating
2.00 .38 Instrument Approach - One Engine Not Operating
2.00 .27 Loss of Gyro Attitude and/or Heading Indicators

POSTFLIGHT PROCEDURES
2.88 .13 Checking Instruments and Equipment

Comments:

Next we have task lists for the ground control station and the Predator that we would like you to rate for importance using the same scale. If there is a task that does not appear on this list, but you feel it should be included, please add it to the comments section along with any other comments you wish to make.

1-Not applicable
2-Nice to have, but not necessary
3-Absolutely necessary

Ground Control Station

3.00 .00 Mission Preparation
3.00 .00 Preflight Preparation/Checklist Use Procedures
2.57 .30 Ground Control Station Start-up
3.00 .00 Preset Procedures
2.71 .29 Air Vehicle Start Procedures

Mean S.E.

3.00 .00 Air Vehicle Engine Run-up/System Check Procedures
3.00 .00 Outbound Taxi Procedures
2.57 .30 Range Check Procedures

3.00 .00 Takeoff Procedures

2.71 .18 Cruise Check Procedures

3.00 .00 Datalink Management Procedures

2.86 .14 En Route Navigation Procedures

2.43 .30 Airborne Operational Data Collection Procedures

3.00 .00 Basic Airmanship Procedures

3.00 .00 Fuel Management Procedures

2.86 .14 Inbound Procedures

3.00 .00 Descent, Landing Pattern, and Landing Procedures

3.00 .00 Roll-out and Return Taxi Procedures

2.86 .14 Engine Shutdown and Post-Flight Procedures

2.86 .14 Internal and External Communication Procedures

2.86 .14 Flight Records Administration Procedures

2.86 .14 Maintenance Forms (AFTO 781) Administrative Procedures

3.00 .00 Emergency Procedures

Comments:

Predator Flying Tasks

3.00 .00 Preflight Prep/Checklist Use

3.00 .00 GCS Start-up/Presets

3.00 .00 Engine Start

Mean S.E.

2.86 .14 Engine Run-up/Systems Check

2.86 .14 UAV Taxi

2.57 .30 Range Checks

3.00 .00 Takeoff

2.86	.14	Cruise Checks
3.00	.00	Hold/Cruise Modes Off
3.00	.00	Straight and Level Flight
3.00	.00	Climbs and Descents
3.00	.00	Turns
2.86	.14	Endurance Airspeed, Flight
2.86	.14	Navigation
2.86	.14	Takeoff Day TV Only
2.86	.14	Land Day TV Only
3.00	.00	Takeoff FLIR Only
3.00	.00	Land FLIR Only
2.86	.14	Operational Mission Task
3.00	.00	Emergency Mission Task
3.00	.00	Fuel Management
3.00	.00	Traffic Pattern
3.00	.00	Go-Around
3.00	.00	Landing
2.86	.14	After Landing
3.00	.00	Engine Shutdown
2.86	.14	IMC Flight
2.71	.18	Instrument Approach
2.43	.30	Unusual Attitude Recovery
3.00	.00	Radio/Communications
3.00	.00	Crew Coordination
3.00	.00	Situation Awareness
Mean	**S.E.**	
3.00	.00	System Knowledge/Scan
2.86	.14	Ku System Operations
2.86	.14	SAR System Operations
2.71	.29	AV Logbook/Tape Management

3.00 .00 Judgment

3.00 .00 Emergency Procedure

Comments:

In this section, please write your response to each question in the space provided.

1. In your opinion, what is the feasibility of selecting and training enlisted personnel to serve as air vehicle operators for the Predator as it exists today? Assume that a separate flight training pipeline will be established for Predator AVOs.

2. What is the sequence of pilot training you received before assignment as Predator AVO? For example, FSP at Hondo, T-37, T-38, C-130

3. What screening requirements were in place that allowed you to be selected for pilot training?

4. What aircraft have you piloted and how many hours do you have in each?

5. Are there skills you gained as a pilot (of conventional USAF aircraft) that interfered with or had negative transfer to Predator flight training?

6. Several Predator AVOs have suggested that situation awareness (SA) is critical to success in the Predator. Assume that Predator AVOs will be trained first in conventional aircraft and then in the Predator. What aspects of SA would be especially important to include in the conventional aircraft phase of a Predator AVO's training? What aspects of SA would be especially important to include in the unmanned air vehicle phase of a Predator AVO's training?

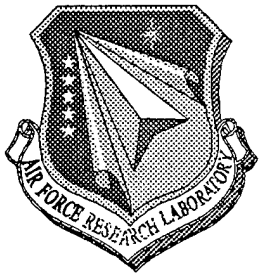
7. Are there any AVO functions that you would recommend to be automated (taken over or assisted by computer) in a future UAV like the Predator given that enlisted personnel would be serving as AVOs?

Appendix C
Briefing to 11th and 15th RS Air Vehicle Operators
9 Dec 1997

Uninhabited Air Vehicle Operator Training Requirements Survey

Briefing to
11th Reconnaissance Squadron
Indian Springs AFAF, Nevada

9 December 1997



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Objective

- Present results of training requirements survey
- Obtain feedback on our interpretation of the data

AVO Training Requirements Survey

- Background
- Research Questions
- Approach
- Survey Design
- Survey Results
- Conclusions
- Recommendations for Next Steps

Background

- Congress requested Air Force to study feasibility of an enlisted air vehicle operator specialty
- Air Combat Command (ACC/DOU) requested support from Air Force Research Laboratory to assist in determining training requirements for enlisted AVOs

Research Questions

- Can enlisted members serve as AVOs?
- What piloting skills should be taught to prepare an AVO candidate for Predator training?
  - Assumption 1: Candidates will be enlisted members with no prior aviation experience
  - Assumption 2: Initial training will be in conventional manned aircraft
- How would skills requirements change with future UAV/UCAV systems?

Approach

- Survey subject matter experts on skills requirements and other issues pertaining to training
- Assuming that AVOs would first undergo training in conventional manned aircraft, survey content was based on the training experiences common to all USAF pilots prior to the T-38 vs. T-1 decision

Survey Design

- Use syllabi from existing programs as source of training tasks
  - T-3 Enhanced Flight Screening Program
  - T-37 Instrument Training Maneuvers
  - T-37 Navigation Training Maneuvers
  - FAA-approved Instrument Rating
  - Predator Initial Qualification Training
- Use 3-point scale
- Ask other training questions in free response format

Results

- 8 AVOs turned in completed surveys
- Substantial agreement among AVOs' ratings of task importance
- Useful but sometimes sketchy responses to free-response questions

Results

Question 1: Could enlisted members serve as AVOs?

- 6 out of 8 officer AVOs definitely asserted that enlisted members could serve as AVOs
- 2 out of 8 officer AVOs did not comment on whether enlisted would be able to serve as AVOs but questioned cost-effectiveness of a separate training pipeline
  - Overlap with UPT is sufficiently great that UPT should be used
  - Use of UPT produces less headaches for training but may have legal consequences
- Informal discussions with several AVOs suggested that AVO should be NCO with experience in an autonomous role

Results

Question 1: Could enlisted members serve as AVOs?

- Respondents recommended future UAVs have several functions automated for enlisted AVOs
  - All functions like DarkStar or Global Hawk
  - Line of sight link type
  - Automatic switching of antennae to best line of sight type
  - Flight planning

Results

Question 2: What piloting skills should be taught to prepare an AVO candidate for Predator operation?

- Items with low ratings fall into three groups:
  - "High dynamic" maneuvers requiring extremely large or rapid changes in parameters (steep turns, spins, inverted recovery, aerobatic maneuvers, instrument confidence maneuvers) which are not performed by the Predator
  - Instrument maneuvers using TACAN/VOR/ILS navigation systems
  - Tasks used to prepare students for unusual flight conditions such as inoperable flaps or tasks which exist for purely training purposes, e.g., Vertical S

Survey Summary:
Number (%) of Tasks by Category

Training Task List	Not Applicable (1.00 - 1.50)		Nice-to-have < Necessary (1.63 - 2.38)		Absolutely Necessary (2.43 - 3.00)	
T-3 Flying	8	(15.1%)	10	(18.9%)	35	(66.0%)
T-37 Instrument Training Maneuvers	0	(0%)	12	(28.6%)	30	(71.4%)
T-37 Navigation Training Maneuvers	0	(0%)	11	(26.8%)	30	(73.2%)
FAA Instrument Rating	0	(0%)	10	(35.7%)	18	(64.3%)
Predator Ground Control Station	0	(0%)	0	(0%)	23	(100%)
Predator Flying	0	(0%)	0	(0%)	38	(100%)
All Tasks	8	(3.6%)	43	(19.1%)	174	(77.3%)

Not Applicable

- T-3 Flying Tasks involving acrobatics:

T-3 F	1.25	Cuban 8
T-3 F	1.25	Chandelle
T-3 F	1.25	Immelman
T-3 F	1.25	Cloverleaf
T-3 F	1.50	Aileron Roll
T-3 F	1.50	Loop
T-3 F	1.50	Lazy 8
T-3 F	1.50	Barrel Roll

Nice to have, but not necessary

- Acrobatics & confidence maneuvers, instrument maneuvers using TACAN/VOR/ILS systems not used by Predator:

T-3 F	1.63	Split S
T-3 F	1.63	Inverted Recovery
T-3 F	1.63	Spin
NAVIGATION AIDS	1.75	Intercepting and Tracking NDB Bearings
T-37 ITM	1.75	High Altitude VOR Approach
T-37 ITM	1.75	Confidence Maneuvers (Wingover, Aileron Roll)
INSTRUMENT APPROACH PROCEDURES	1.88	NDB Instrument Approach Procedures

Nice to have, but not necessary

- Acrobatics & instrument maneuvers using TACAN/ VOR/ILS systems not used by Predator:

T-3 F	2.00 Spin Prevention
T-37 ITM	2.00 Course Interception/RMI Only
T-37 ITM	2.00 Maintaining Course/RMI Only
T-37 NAV	2.00 High Altitude VOR Approach
FLIGHT BY REFERENCE TO INSTRUMENTS	2.00 Steep Turns
EMERGENCY OPERATIONS (MULTIENGINE)	2.00 Instrument Approach - 1 Engine Not Operating
EMERGENCY OPERATIONS (MULTIENGINE)	2.00 Loss of Gyro Attitude and/or Heading Indicators

Nice to have, but not necessary

- Instrument maneuvers using TACAN/VOR/ILS systems not used by Predator & flying tasks with no application to Predator:

T-3 F	2.13 Glides No Flap
T-3 F	2.13 Slow Flight No Flap
T-3 F	2.13 VOR Operation/Orientation
T-37 ITM	2.13 Localizer Approach
T-37 NAV	2.13 Fix-To-Fix Navigation
NAVIGATION AIDS	2.13 Intercepting & Tracking VOR/VORTAC Radials and DME arcs
INSTRUMENT APPROACH PROCEDURES	2.13 VOR/VORTAC Instrument Approach Procedures
INSTRUMENT APPROACH PROCEDURES	2.13 ILS Instrument Approach Procedure

Nice to have, but not necessary

- Confidence maneuvers, instrument maneuvers using TACAN/VOR/ILS systems not used by Predator:

T-37 ITM	2.25 Maintaining Arc
T-37 ITM	2.25 Fix-To-Fix
T-37 ITM	2.25 Low Altitude VOR Approach
T-37 NAV	2.25 VFR Course Maintenance
T-37 NAV	2.25 VOR Course Intercepts
T-37 NAV	2.25 VOR Course Maintenance
T-37 NAV	2.25 Low Altitude VOR Approach
T-37 NAV	2.25 VOR Final Approach
T-37 NAV	2.25 ILS Approach
T-37 NAV	2.25 Localizer Approach
FLIGHT BY REFERENCE TO INSTRUMENTS	2.25 Timed Turns to Magnetic Headings
T-3 F	2.25 Steep Turns
T-3 F	2.25 Traffic Pattern Stalls - No Flap
T-3 F	2.25 Pattern Breakout
T-37 ITM	2.25 Steep Turns

Nice to have, but not necessary

- Instrument maneuvers using TACAN/VOR/ILS systems not used by Predator & flying tasks with no application to Predator:

T-37 ITM	2.38 Vertical S
T-37 ITM	2.38 ILS Approach
T-37 ITM	2.38 No-Gyro Approach
T-37 NAV	2.38 Circling Approach
T-37 NAV	2.38 Lost Procedures
ATC CLEARANCES & PROCEDURES	2.38 Holding Procedures

Results

Question 2: What piloting skills should be taught to prepare an AVO candidate for Predator operation?

- No specific examples of negative transfer from conventional manned aircraft were noted in free-responses but single-propeller aircraft experience was mentioned as positive
- Situation awareness
  - Most respondents did not give specific recommendations but encouraged SA training
  - Training to enhance "telepresence"
  - Training on thinking ahead of aircraft & anticipating events/mission requirements

Results

Question 3: How would skills requirements change with UCAV designed for SEAD mission?

- Specific recommendations:
  - All training tasks would be a "4" (something beyond "absolutely necessary")
  - All acrobatics would be "3" instead of a "2"
  - Include enemy threat courses in an MQT program
- 5/8 AVOs did not respond to this question

Conclusions

- Enlisted should be able to serve as AVOs
- Training requirements prior to Predator
  - Equivalent to FAA Instrument Rating
  - Conventional aircraft phase need not incorporate aerobatics or jet trainers
  - Question exists regarding separate pipeline vs. use of existing UPT
    - » tradeoff between cost of using jets vs. developing new course
    - » possibility of out-sourcing pre-Predator AVO training to civilian school
- No conclusions regarding next generation UAVs

Next Steps

- Incorporate Predator AVO comments & suggestions
- Conduct research to estimate proportion of airmen who would qualify for pilot training
  - Existing data suggest mean of airmen distribution on AFOQT is significantly lower than that of officers

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